

NAVFAC EXWC Develops Low Impact Development Decision Tool

Software Helps Facilities Maintain NPDES Permit Compliance

THE NAVY IS under increasing pressure from regulators and local communities to reduce the amount of pollutants being discharged into harbors, bays, lakes and streams from stormwater runoff. Many installations must comply with the stormwater requirements associated with the National Pollutant Discharge Elimination System (NPDES) permitting program.

To relieve some of this pressure, engineers from the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) partnered with personnel from the Low Impact Development (LID) Center with funding provided by the Navy Environmental Sustainability Development to Integration (NESDI) program to produce a stormwater management Decision Support System (DSS). This DSS supports the implementation of LID best management practices (BMP) and is specifically engineered for Navy

industrial areas such as scrap metal recycling facilities, motor pools, metal fabrication shops and storage areas.

Low Impact Development Best Management Practices

Knowledge of LID BMPs is a valuable tool for planners and stormwater managers to help reduce particular pollutant loads at their facilities to achieve compliance with their NPDES stormwater permits. Installations are challenged with identifying the best, most cost-effective methods for compliance with NPDES permit limits and benchmarks from both operational and nonindustrial areas.

Stormwater runoff from Navy installations is roughly characterized as having dissolved and/or particulate metals, moderate suspended solids and organic content, and low nutrient and bacterial content. The metal content in stormwater runoff from industrial sites may be attributed to

outdoor metal working processes such as cutting and grinding, outdoor storage of metal objects and use of metal bearing materials such as corrosion inhibiting and anti-fouling paints.

The primary contaminants of concern for permit compliance include lead, copper and zinc. The regulatory requirements are typically based on acute and/or chronic toxicity levels, or specific concentrations of the metals in the runoff. Acute toxicity occurs when the concentration can cause severe impacts or be toxic to one or more species, often referred to as indicator species, over a short period of time. Chronic toxicity results when prolonged exposure to the pollutant causes severe impacts or is toxic to an organism or species.

Compliance is achieved through a multi-phase process. An important first step is implementation of non-structural BMPs. Non-structural BMPs are simple, low-cost management

Knowledge of LID BMPs is a valuable tool for planners and stormwater managers to help reduce particular pollutant loads at their facilities to achieve compliance with their NPDES stormwater permits.

The Basics About the LID Center

THE LID CENTER is a non-profit, national research organization that focuses on sustainable stormwater management solutions for urban and developing areas.

LID Center personnel work both independently and in partnership with numerous research organizations, private entities and other non-profit organizations to conduct research, provide concept designs, implement pilot projects, prepare manuals of practice and conduct training.

For more information, visit <http://lowimpactdevelopment.org>.



practices that reduce the potential for contamination of stormwater runoff.

If after all applicable non-structural BMPs have been implemented, contaminants in the stormwater runoff still exceed the permitted discharge limits; treatment of stormwater runoff is required. Treatment measures of stormwater runoff that reduce runoff volume or pollutant concentration are referred to as “structural BMPs.”

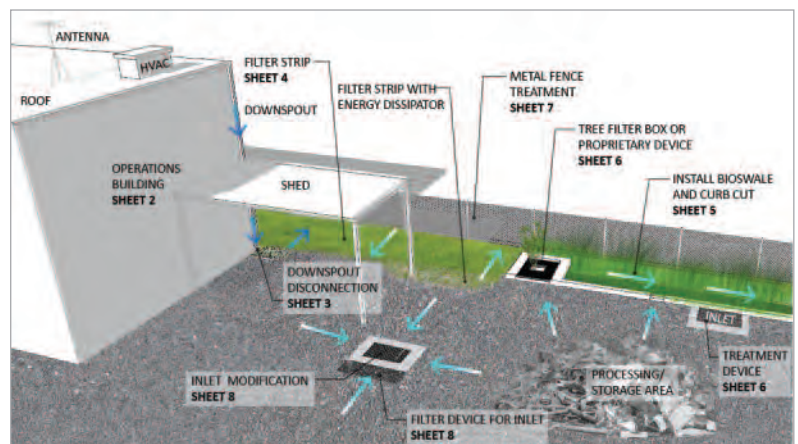
LID is a land planning and engineering design approach that strives to mimic natural hydrology to capture and/or treat stormwater runoff. LID BMPs are structural BMPs that use natural processes to remove contaminants from stormwater runoff that inherently have low operation and maintenance costs since they typically do not incorporate mechanical devices which tend to require constant maintenance and eventually wear out and break over time. In addition, LID BMPs may be engineered to target

problematic metal pollutants and total suspended solids in stormwater runoff from industrial and urban areas.

Cost effectiveness and feasibility for different LID BMPs and locations vary greatly. Some features may be too expensive or cause major disruption to the surrounding landscape.

The stormwater management DSS is organized and presented through a series of flowcharts and templates of typical industrial facilities and potential pollution sources, and potential LID BMP solutions. The application and modification of conventional non-structural and structural BMP approaches may be required for unique physical and operational requirements of Navy industrial activities. A series of templates guide the user through the proper location, configuration and design of the practices. The figure below shows potential industrial area LID BMP options. The following design templates are provided in the stormwater management DSS:

- Sheet 1: Schematic of BMPs
- Sheet 2: Building Improvements
- Sheet 3: Downspout Disconnection
- Sheet 4: Filter Strip
- Sheet 5: Bioswale and Curb Cut
- Sheet 6: Tree Box Filter and Proprietary Devices
- Sheet 7: Metal Fence Treatment
- Sheet 8: Inlet Modification
- Sheet 9: Processing and Storage Area
- Sheet 10: Curb Cut



Schematic of potential LID treatment options.

Removal of pollutants from stormwater runoff is achieved by applying a combination of physical, chemical and biological unit processes.

The stormwater management DSS presents a “common sense” approach for the selection of cost-effective BMPs for reducing heavy metals runoff from industrial areas. The selection of BMPs location, configuration, and design may be an iterative process. The DSS process for stormwater management is illustrated in the figure below.

- Permeable Friction Course
- Permeable Pavement
- Vegetated Filter Strips
- Tree Box Filter

Selection of Structural BMP Technologies

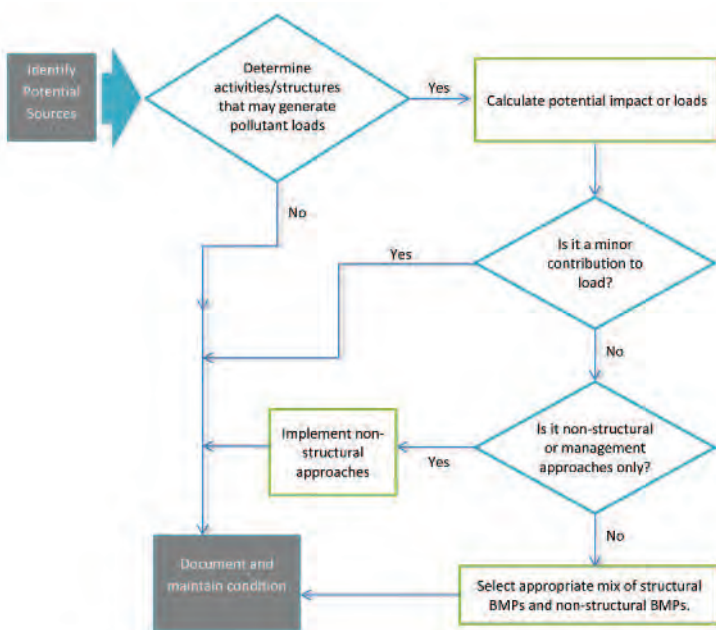
A wide range of factors must be considered when selecting structural BMPs. These include, but are not limited to, efficiency of treatment, cost for construction, availability of materials, durability, maintenance requirements and appearance. The user must develop criteria for use at the installation or for the specific activity in order to meet the selection requirements. A series of matrices and tables are used to assist in the selection of BMPs.

Removal of pollutants from stormwater runoff is achieved by applying a combination of physical, chemical and biological unit processes. The table below summarizes the processes that are used to reduce the pollutant load of metals in the dissolved and particulate forms.

TREATMENT PROCESSES

Process	Particulate Metals	Dissolved Metals
Sedimentation	X	
Filtration	X	
Sorption & Ion Exchange		X
Precipitation		X
Complexation		X
Plant Uptake		X

Stormwater runoff will often contain metals in both the dissolved and particulate form. An understanding of the pollutant load and source is critical to the selection of a BMP or BMPs to effectively treat the runoff. In general, the more processes BMPs make use of, the better able they are to remove pollutants down to lower concentration levels.



Stormwater management DSS flowchart.

The treatment of contaminated runoff may be accomplished through combinations of biological, chemical and physical processes. A series of factsheets is provided to the user with detailed information on sizing, design, construction, effectiveness and maintenance of the LID BMPs. Factsheets provided in the DSS include the following LID BMPs:

- Bioswale
- Filter Mat
- Sand/Media Filters

For More Information

YOU CAN DOWNLOAD a copy of the Stormwater DSS technical report (The Stormwater Management Decision Support System for Using Low Impact Development Best Management Practices in Industrial Areas, TR-NAVFAC-EXWC-EV-1507) from the Defense Technical Information Center at www.dtic.mil/get-tr-doc/pdf?AD=ADA626185.



A treatment train of BMPs that employ these three unit processes in sequence is likely to provide effective removal of heavy metals, if each of the components is well designed. The table below lists some common standard LID BMPs that are effective at treating heavy metals and are appropriate for use in industrial areas and their associated unit processes.

Sedimentation would initially remove coarse solids such as sand, grit and metal filings, reducing particulate loads. After sedimentation, filtration would provide removal of fine suspended solids. Lastly, dissolved metals can be removed through sorption.

Facility Criteria for Selection of BMPs

When selecting a BMP or BMPs for a site, consideration must be given to the particular physical and spatial requirements, potential impact on operations of the

COMPARISON OF THE UNIT PROCESSES EMPLOYED BY LID STORMWATER BMPs

Process	Bioretention	Bioswale	Biofilter	Permeable Pavement	Media Filter	Permeable Friction Course	Compost Filter Mat	Vegetated Filter Strip	Inlet Insert
Sedimentation	X	X				X		X	X
Filtration	X	X	X	X	X	X	X	X	X
Sorption & Ion Exchange	X	X	X		X	X	X		X
Precipitation	X	X	X		X	X	X		X
Complexation	X	X	X		X	X	X		X
Volatilization	X	X	X		X	X		X	X
Microbial Immobilization	X	X	X			X	X	X	X
Microbial Transformation:									
• Ammonification	X	X	X					X	X
• Nitrification	X	X	X	X				X	X
• Denitrification	X		X						
Plant Uptake	X	X				X	X	X	X

RELATIVE PERFORMANCE & REQUIREMENTS OF LID BMPs

BMP	REMOVAL EFFECTIVENESS			EFFICIENCY	
	Metals	Nitrogen	Space	Cost ¹	Maintenance
Bioretention ²	■	■	■	■	■
Bioswale	■	■	■	■	■
Biofilter	■	■	■	■	■
Media Filter ³	■	■	■	■	■
Permeable Friction Course	■	■	■	■	■
Compost Filter Mat	■	■	■	■	■
Vegetated Filter Strip	■	■	■	■	■
Inlet Insert	■	■	■	■	■

■ good ■ moderate ■ poor

¹Pomeroy and Rowney, 2013

²Hunt et al, 2012

³Anguiano and Foreman, 2008

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.



For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or ken.kaempffe@navy.mil.

facility, as well as capital costs and ongoing maintenance requirements.

The size and drainage area considerations vary greatly due to regional climate conditions and regulatory requirements. State and local government stormwater design and construction manuals often dictate the type and sizing methods that are used for post-construction stormwater management practices. This prescriptive approach is developed to treat a wide range of pollutants. It may be necessary to modify the designs and sizing strategies to allow for more effective treatment of heavy metals. Users should consult state and local stormwater design manuals for more detailed guidance on estimating the size of the facilities.

The size and drainage area considerations vary greatly due to regional climate conditions and regulatory requirements.

Other stormwater management objectives should also be considered when selecting LID BMPs. The table above rates the relative performance, maintenance and lifecycle costs factors that may help DSS users to identify the best solutions to their particular permit requirements. ⚓

Vern Novstrup
Naval Facilities Engineering and Expeditionary Warfare Center
805-982-1276
DSN: 551-1276
vern.novstrup@navy.mil